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This appendix describes the baseline and energy efficiency measure data used in the study. The remaining appendices contain a complete listing of the data used in our modeling process.

A.1 BASELINE DATA

The principal baseline data used in this study consist of end use and technology specific data as well as economic data (avoided costs and commercial rates).

A.1.1 End Use and Technology Specific Data

Estimating the potential for energy-efficiency improvements requires a comparison of the energy impacts of existing, standard-efficiency technologies with those of alternative high-efficiency equipment. This, in turn, dictates a relatively detailed understanding of the statewide energy characteristics of the existing marketplace. Data that were required at the utility service area and building type level for each end use studied included:

- Annual energy consumption per home;
- End use load shapes and energy/peak factors;
- Electric end use saturations, and
- Technology shares.

Sources for and development of each of these key data elements are discussed in the following subsections.

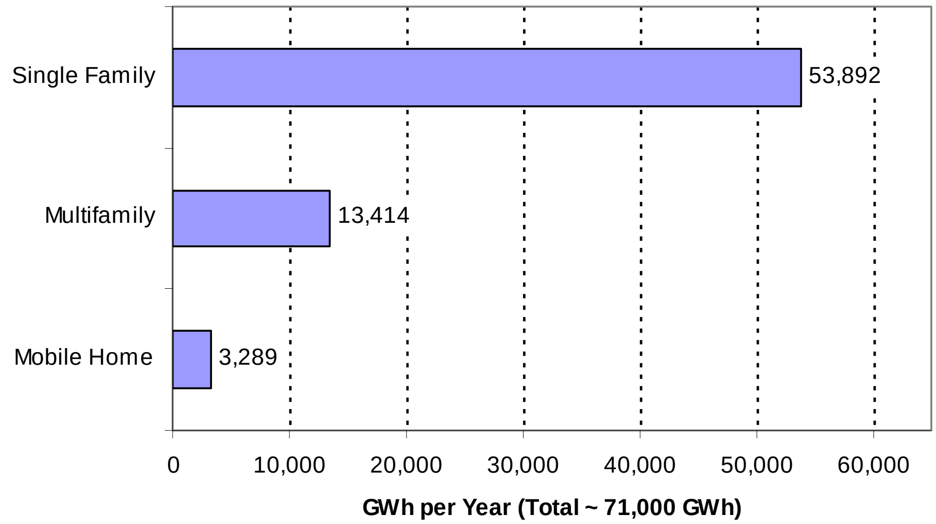
End Use Energy Consumption

The primary source used for end use energy consumption is the CEC residential end use forecasting database[1]. In the end use forecasting approach, end use energy consumption is expressed as the product of the number of homes, the fraction of homes associated with a given end use (the end use saturation), and UEC (the unit energy consumption of an end use, expressed in kWh and therms per home). These three data elements have been collected and estimated from various sources over time and form the foundation upon which the CEC energy demand forecasts are developed.

Figure A-1 summarizes residential electricity usage by building type. In 2000, residential energy usage for the three major California electric utilities was about 71,000 GWh. Single family dwellings accounted for about three quarters of this usage, or about 54,000 GWh. Figure A-2 summarized natural gas usage by building type. Again, single family dwellings account for about three quarters of the 5,000 Mth of natural gas used by residential customers in 2000.

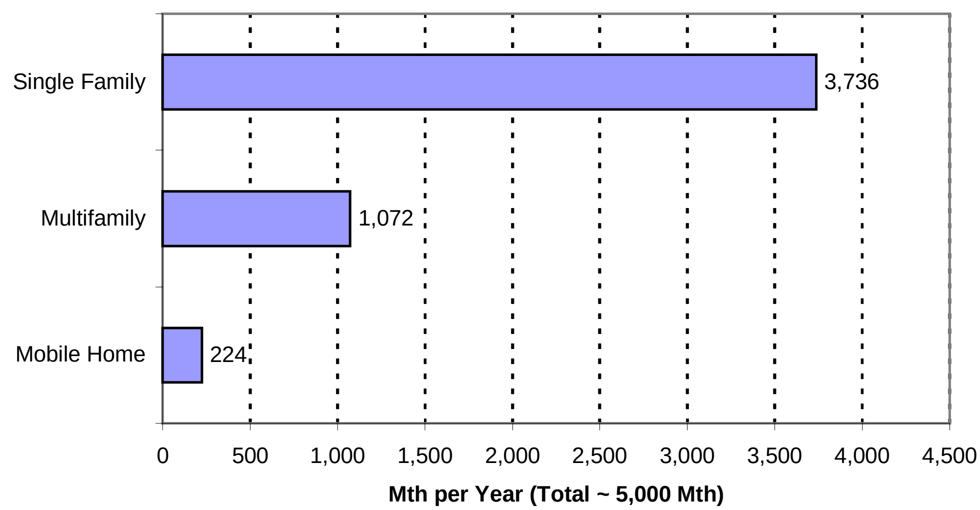
[1] For the SDG&E service territory, SDG&E's space cooling and heating energy usage estimates were utilized because it was determined that the SDG&E figures better reflect recent SDG&E customer growth in the more extreme climate areas.

Figure A-1
Residential Electricity Usage by Building Type*



*Includes line losses. Source: CEC 2000. *California Energy Demand: 2000-2010*.

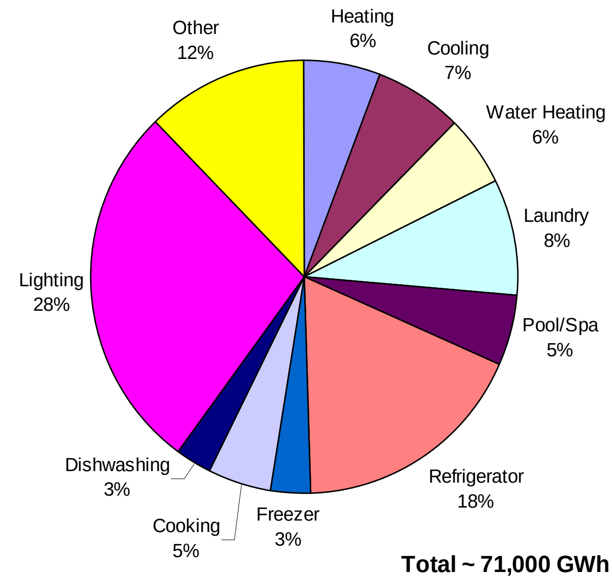
Figure A-2
Residential Natural Gas Consumption by Building Type



Source: CEC 2000. *California Energy Demand: 2000-2010*.

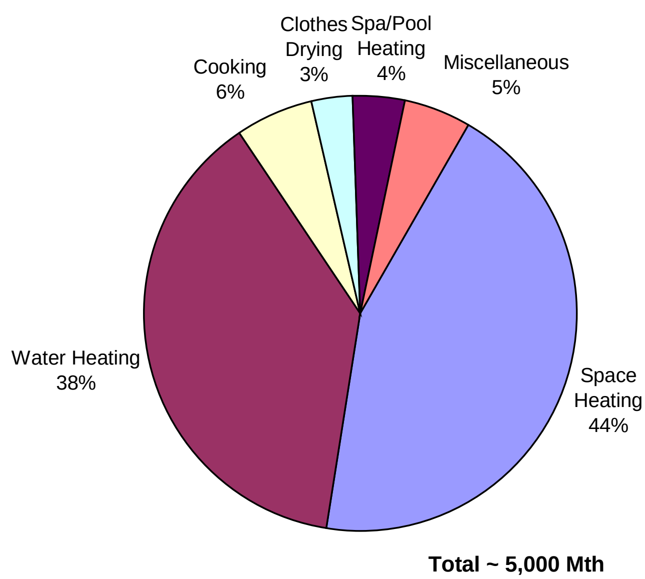
Figure A-2 summarizes the CEC's estimates of residential electricity use by end use, and Figure A-4 summarizes the natural gas end use breakdown. Our final UECs are shown, by technology, in Appendix C. As shown, the largest electric end uses are lighting and refrigeration, which account for about 46 percent of total usage. Space heating and water heating are the largest gas end uses, accounting for about 82 percent of total natural gas usage.

Figure A-3
CEC Residential Electricity Usage Breakdown by End Use for Major IOUs*



*Includes line losses. Source: CEC 2000. *California Energy Demand: 2000-2010 and XENER*Y analysis.

Figure A-4
Breakdown of Residential Gas Consumption by End Use



Source: CEC 2000. *California Energy Demand: 2000-2010.*

Load shapes and Energy / Peak ("H") Factors

Electric load shap data was used to develop factors that were applied to both electricity and natural gas energy use. Energy and peak factors are used to allocate annual energy usage into utility costing periods and to provide estimates of peak demand based on cost period energy usage. The factors were developed by end use, and by climate zone for weather-sensitive end uses, and were used to allocate measure impacts to utility costing periods for purposes of estimating avoided-cost benefits. The energy and peak factors are sometimes referred to as "H" factors.

In the case of the electric energy factors, these factors are computed based on predefined costing periods (e.g., season, day of the week, and hours of the day) divided by annual electric use. The end result is a series of values for each period such that the sum of the periods is equal to one.

The peak factors are based on the same predefined periods as the energy factors. In this case, the peak demand within a cost period is divided by the average demand within that same period; that is, the peak factor is the ratio of peak to average demand in a period. This is done for both noncoincident demands as well as for coincident demands. In the case of coincident demands, the time of coincidence was set to be the time at which the California electric system typically peaked within each marginal costing period.

The costing periods used are consistent with the recently completed California commercial energy efficiency potential study (XENERGY 2002a). Table A-1 provides the costing period definitions, and Table A-2 identifies peak hours used in the analysis.

Table A-1
Costing Period Definitions Used for Electric Energy Factors

	Season	
Period	Summer (May 1 - Oct 31)	Winter (All Other Months)
Peak	1 P.M. to 6 P.M. Weekdays	(none)
Partial-Peak	9 A.M. – 12 P.M. Weekdays 7 P.M. – 9 P.M. Weekdays	9 A.M. – 9 P.M. Weekdays
Off-Peak	10 P.M. – 8 A.M. Weekdays All Weekends and Holidays	10 P.M. to 8 A.M. Weekdays All Weekends and Holidays

Table A-2
Peak Hours for Each TOU Period

Season	TOU Period	Month	Daytype	Hour
Winter	Semi-peak	January	Coldest	0800
	On-peak	January	Coldest	1800
Summer	Off-peak	August	Hottest	2200
	Semi-peak	August	Hottest	1200
	On-peak	August	Hottest	1600

The data used to develop the load shape/time-of-use factors used in the study were obtained from two sources:

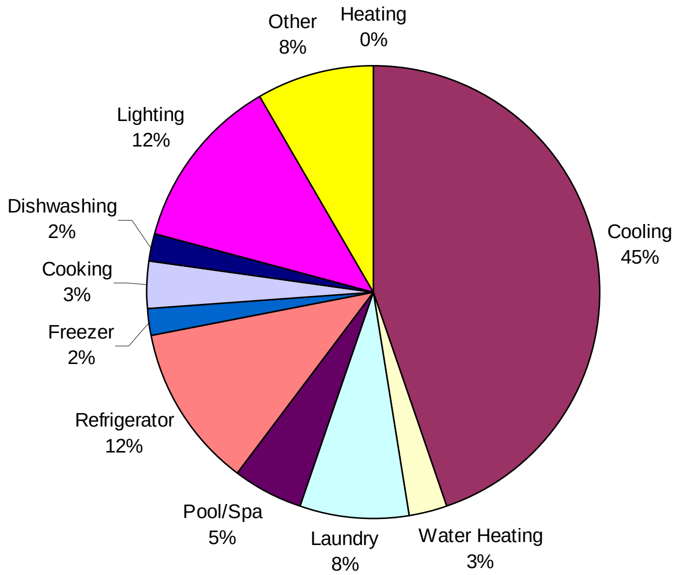
- The CEC forecasting database for non-weather-sensitive measures; and
- Interim data sets developed for the *2001 DEER Update Study* for weather-sensitive end uses.

Examples of the electric energy and peak factors developed are shown in Table A-3. By combining these factors with annual end use energy consumption figures, estimates of residential peak demand can be developed for each end use. Figure A-5 shows the end use allocation of peak demand developed for this study.

Table A-3
Example of Electric Energy Factors – Single Family, Climate Zone 4

End Use	Season	TOU Period	Energy Factor	Coincident Peak Factor
Space Cooling	Summer	Peak	0.5499	2.59157
Space Cooling	Summer	Semi-Peak	0.1568	7.99963
Space Cooling	Summer	Off-Peak	0.2933	18.30366
Space Cooling	Winter	Semi-Peak	0.0000	1.00000
Space Cooling	Winter	Off-Peak	0.0000	1.00000
Lighting	Summer	Peak	0.0754	0.89030
Lighting	Summer	Semi-Peak	0.1263	1.04986
Lighting	Summer	Off-Peak	0.2628	2.37492
Lighting	Winter	Semi-Peak	0.2402	1.48416
Lighting	Winter	Off-Peak	0.2953	0.90755
Refrigeration	Summer	Peak	0.0989	1.00812
Refrigeration	Summer	Semi-Peak	0.1125	1.05763
Refrigeration	Summer	Off-Peak	0.3237	1.10497
Refrigeration	Winter	Semi-Peak	0.1809	1.04935
Refrigeration	Winter	Off-Peak	0.2840	0.91572
Water Heating	Summer	Peak	0.0828	0.88854
Water Heating	Summer	Semi-Peak	0.1118	1.04237
Water Heating	Summer	Off-Peak	0.2502	1.13306
Water Heating	Winter	Semi-Peak	0.2602	0.95315
Water Heating	Winter	Off-Peak	0.2949	1.26874
Space Heating	Summer	Peak	0.0000	0.00000
Space Heating	Summer	Semi-Peak	0.0011	0.00000
Space Heating	Summer	Off-Peak	0.0116	1.00000
Space Heating	Winter	Semi-Peak	0.1678	1.00000
Space Heating	Winter	Off-Peak	0.8196	1.00000

Figure A-5
Residential Peak Demand End Use Breakdown for Major IOUs*



*Includes line losses. Source: RER Inc. and XENERGY Inc. analysis.

A.1.2 Energy Cost Data

Energy cost data is another important component of this study. These data are described in Section 5. Tables A-4 and A-5 summarize our energy cost and rate assumptions.

Table A-4
Summary of Base Energy Cost Element

Fuel	Cost Type	Description	Source
Electricity	Avoided Costs	Annual avoided cost averages roughly 3.5 to 19 cents per kWh depending on the end use affected. See Figures 5-1 and 5-2 and Appendix B for specific values.	CPUC authorized avoided costs for major IOU's 2001 cost-effectiveness analyses (CPUC 2000).
	Residential Rates	Estimates of current average residential IOU rates that decline by 4 percent per year in real terms over the 2003-2012 period.	CEC's most recent residential price forecast (dated July 19, 2002).
Natural Gas	Avoided Costs	Annual avoided cost averages 46 cents per therm and remains relatively unchanged in real terms throughout the forecast horizon.	CPUC authorized avoided costs for 2002 program cost-effectiveness analyses (CPUC 2001).
	Residential Rates	Annual average rate of 63 cents per therm in 2003 that remains relatively flat, in real terms, throughout the forecast horizon.	EIA average residential prices for California, 12 months ending March 2000; CPUC authorized avoided costs for 2002 program cost-effectiveness analyses (CPUC 2001).

Table A-5
Summary of Low and High Energy Cost Elements

		Energy Costs Element	
Fuel	**Cost Type**	**Low**	**High**
Electricity	Avoided Costs	50 percent lower than Base avoided costs.	25 percent higher than Base avoided costs.
	Residential Rates	2 cents per kWh below Base rates.	Current actual rates that persist, in real terms, throughout forecast period.
Natural Gas	Avoided Costs	50 percent lower than Base avoided costs.	50 percent higher than Base avoided costs.
	Residential Rates	50 percent lower than Base rates.	50 percent higher than Base rates.

A.2 Energy Efficiency Measure Data

This subsection presents information on the energy efficiency measures included in the study. Cost and savings fraction sources are listed and measure descriptions are provided.

A.2.1 Measures Included

The set of measures included in this potential study is shown in Table A-6 (electric) and Table A-7 (natural gas) below. In reviewing this list, readers should be aware of the following:

- Measures are generally organized around base case technologies. These base case technologies are intentional aggregations of the wide variety of actual base case technologies in the market. Thus, the measure list for the potential study is not as detailed as measure lists that are necessary for actual program implementation.
- The measures shown in the tables were selected by starting with the *DEER 2001 Update Study*, with some aggregation to prototypical applications. We then reviewed utility and third-party PY2002 filings and program documentation and added measures that could have significant potential but were not on the DEER list.

Table A-6
Residential Electric Measure List

End Use	Measure #	Measure Name
Space Cooling	100	Base, 10 SEER Split-System Air Conditioner
Space Cooling	101	10 to 12 SEER Split-System Air Conditioner
Space Cooling	102	10 to 13 SEER Split-System Air Conditioner
Space Cooling	103	10 to 14 SEER Split-System Air Conditioner
Space Cooling	105	TXV
Space Cooling	109	Programmable Thermostat (0.4)
Space Cooling	110	Ceiling Fans

Table A-6
Residential Electric Measure List

End Use	Measure #	Measure Name
Space Cooling	111	Whole House Fans
Space Cooling	112	Attic Venting
Space Cooling	113	Basic HVAC Diagnostic Testing And Repair
Space Cooling	114	Duct Repair (0.32)
Space Cooling	115	Duct Insulation (.4)
Space Cooling	116	Cool roofs
Space Cooling	117	Window Film
Space Cooling	118	Default Window With Sunscreen
Space Cooling	119	Double Pane Clear Windows to Double Pane, Med Low-E Coating
Space Cooling	120	Ceiling R-0 to R-19 Insulation Blown-in (.29)
Space Cooling	121	Ceiling R-19 to R-38 Insulation Blown in (.27)
Space Cooling	122	Wall 2x4 R-0 to Blow-In R-13 Insulation (0.14)
Space Cooling	123	Infiltration Reduction (0.4)
Space Cooling	140	Base Room Air Conditioner - SEER 8.8
Space Cooling	141	HE Room Air Conditioner - SEER 10.3
Space Cooling	143	Programmable Thermostat (0.4)
Space Cooling	144	Ceiling Fans
Space Cooling	145	Whole House Fans
Space Cooling	146	Attic Venting
Space Cooling	147	Basic HVAC Diagnostic Testing And Repair
Space Cooling	148	Cool roofs
Space Cooling	149	Window Film
Space Cooling	150	Default Window With Sunscreen
Space Cooling	151	Double Pane Clear Windows to Double Pane, Med Low-E Coating
Space Cooling	152	Ceiling R-0 to R-19 Insulation Blown-in (.29)
Space Cooling	153	Ceiling R-19 to R-38 Insulation Blown in (.27)
Space Cooling	154	Wall 2x4 R-0 to Blow-In R-13 Insulation (0.14)
Space Cooling	155	Infiltration Reduction
Space Heating	180	Resistance Space Heating
Space Heating	181	Heat Pump Space Heater
Space Heating	182	Programmable Thermostat
Space Heating	183	Ceiling R-0 to R-19 Insulation-Batts
Space Heating	184	Ceiling R-19 to R-38 Insulation-Batts
Space Heating	185	Floor R-0 to R-19 Insulation-Batts
Space Heating	186	Wall 2x4 R-0 to Blow-In R-13 Insulation
Space Heating	187	Infiltration Reduction
Lighting	200	Base Lighting, 0.5 hr/hday
Lighting	201	CFL, 0.5 hr/day
Lighting	210	Base Lighting, 2.5 hr/hday
Lighting	211	CFL, 2.5 hr/day
Lighting	220	Base Lighting, 6.0 hr/hday
Lighting	221	CFL, 6.0 hr/day
Lighting	230	Base Fluorescent Fixture, 2L4'T12, 40W, 1EEMAG
Lighting	231	ROB 2L4'T8, 1EB
Lighting	232	RET 2L4'T8, 1EB
Refrigerators	300	Base Refrigerator

Table A-6
Residential Electric Measure List

End Use	Measure #	Measure Name
Refrigerators	301	HE Refrigerator - Energy Star
Refrigerators	302	Refrigerator - Early Replacement
Freezers	400	Base Freezer
Freezers	401	HE Freezer
Water Heating	500	Base 40 gal. Water Heating (EF=0.88)
Water Heating	501	Heat Pump Water Heater (EF=2.9)
Water Heating	502	HE Water Heater (EF=0.93)
Water Heating	503	Solar Water Heat
Water Heating	504	Low Flow Showerhead
Water Heating	505	Pipe Wrap
Water Heating	506	Faucent Aerators
Water Heating	507	Water Heater Blanket
Clothes Washing	600	Base Clothes Washer (EF=1.18)
Clothes Washing	601	Energy Star CW (EF=2.5)
Clothes Washing	602	SEHA CW Tier 2 (EF=3.25)
Clothes Drying	700	Base Clothes Dryer (EF=.46)
Clothes Drying	701	HE Clothes Dryer (EF=.52)
Dishwashing	800	Base Dishwasher (EF=0.46)
Dishwashing	801	Energy Star DW (EF=0.58)
Pools	900	Base Pool Pump and Motor
Pools	901	High Efficiency Pool Pump and Motor

Table A-7
Residential Natural Gas Measure List

End Use	Measure #	Measure Name
Space Heating	180	Base Furnace, 80 AFUE, 80 kbtu
Space Heating	181	Condensing Furnace, 92 AFUE
Space Heating	182	Programmable Thermostat (.6)
Space Heating	183	Ceiling R-0 to R-19 Insulation Blown-in (.71)
Space Heating	184	Ceiling R-19 to R-38 Insulation Blown in (.73)
Space Heating	185	Floor R-0 to R-19 Insulation-Batts
Space Heating	186	Wall 2x4 R-0 to Blow-In R-13 Insulation (.86)
Space Heating	187	Infiltration Reduction (.6)
Space Heating	188	Duct Repair (0.68)
Space Heating	189	Duct Insulation (.6)
Space Heating	190	Basic HVAC Diagnostic Testing And Repair
Water Heating	500	Base 40 gal. Water Heating (EF=0.60)
Water Heating	502	HE Water Heater (EF=0.63)
Water Heating	503	Solar Water Heat
Water Heating	504	Low Flow Showerhead
Water Heating	505	Pipe Wrap
Water Heating	506	Faucent Aerators
Water Heating	507	Water Heater Blanket
Water Heating	520	Base Boiler (Eff=0.82)
Water Heating	522	HE Boiler (EF=0.95)
Water Heating	523	Solar Water Heat
Water Heating	524	Low Flow Showerhead
Water Heating	526	Faucent Aerators
Water Heating	528	Boiler Controls
Clothes Washing	600	Base Clothes Washer (EF=1.18)
Clothes Washing	601	Energy Star CW (EF=2.5)
Clothes Washing	602	SEHA CW Tier 2 (EF=3.25)
Clothes Drying	700	Base Clothes Dryer (EF=.46)
Clothes Drying	701	HE Clothes Dryer (EF=.52)
Dishwashing	800	Base Dishwasher (EF=0.46)
Dishwashing	801	Energy Star DW (EF=0.58)

A.2.2 Measure Cost and Savings Sources

Most of the measure cost and savings data for this study were developed as part of the DEER 2001 Update study. Part of that study involved collection and analysis of residential and commercial measure cost data. A second part of the study focused on development of savings fractions for residential measures. All measure cost and savings estimates are shown in Appendix C for electric measures and Appendix D for gas measures.

A.2.3 Existing Energy-Efficient Measure Saturations

In order to assess the amount of energy efficiency savings available, estimates of the current saturation of energy efficient measures were developed from available data sources. Key sources for this study include:

- The Statewide Residential Lighting and Appliance Saturation Study (RLW 2000), and
- The Residential Market Share Tracking Project (RER, 2001 and 2002).

A.2.4 Description of Measures Included in the Study

This subsection provides brief descriptions of the measures included in this study.

HVAC

Central Air Conditioner Upgrade: Air conditioner equipment includes a compressor, an air-cooled or evaporatively-cooled condenser (located outdoors), an expansion valve, and an evaporator coil (located in the supply air duct near the supply fan). Cooling efficiencies vary based on the quality of the materials used, the size of equipment, the condenser type and the configuration of the system. Central air conditioners may be of the unitary variety (all components housed in a factory-built assembly) or be a split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines and with the compressor at either the outdoor or indoor location). Efficient air conditioner measures involve the upgrade of a standard efficiency unit (10 SEER) to a higher efficiency unit (12, 13, or 14 SEER).

TXV: Thermostatic expansion valves optimize refrigerant flow over a wide range of load conditions. The TXV helps regulate the refrigerant to match the load conditions inside the home, thereby reducing compressor use. The air conditioners then operate about 10-20 percent more efficiently.

High Efficiency Room Air Conditioner: Window (or wall) mounted room air conditioners are designed to cool individual rooms or spaces. This type of unit incorporates a complete air-cooled refrigeration and air-handling system in an individual package. Cooled air is discharged in response to thermostatic control to meet room requirements. Each unit has a self-contained, air-cooled direct expansion (DX) cooling system and associated controls. The efficient room air conditioner measure involves the upgrade of a standard efficiency unit (8.8 SEER) to a higher efficiency unit (10.3 SEER).

Heat Pump: Heat pumps consist of a refrigeration system using a direct expansion cycle. Equipment includes a compressor, an air-cooled or evaporatively-cooled condenser (located outdoors), an expansion valve, an evaporator coil (located in the supply air duct near the supply fan) and a reversing valve to change the DX cycle from cooling to heating when required. The cooling and heating efficiencies vary based on the quality of the materials used, the size of equipment, the condenser type and the configuration of the system. Heat pumps may be of the unitary variety (all components housed in a factory-built assembly) or be a split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines and with the compressor at either the outdoor or indoor location).

Condensing Furnace 92 AFUE: Condensing furnaces have annual fuel use efficiencies (AFUEs) of 90 percent or higher, compared to standard efficiency furnaces with AFUEs of around 78. Efficiency is dependent on vent type, burner type and heat transfer surface. Condensing furnaces derive useful heat from condensing vaporized by-products of combustion by exchanging this heat with the circulating indoor air stream. Furnaces with intermediate efficiencies (82 percent to 90 percent) typically form condensate and have high flue gas temperatures that require costly, corrosion-resistant metals for the venting system. For this measure, it is assumed that a standard-efficiency central furnace is replaced with a condensing furnace.

Programmable Thermostat: A clock thermostat reduces the heating set point or increases the cooling set point during programmed periods during the day or week. This method of control is used, most often, to reduce heating and cooling energy use during unoccupied periods. Clock thermostats for heating and cooling units are available in one-day, seven-day, and 365-day programmable versions, with a battery backup in case of power failure. Clock thermostats are available in electronic and mechanical versions.

Ceiling Fans: The convective heat transfer from the body depends on the velocity of the air moving over it. Humans can remain comfortable in a warm humid environment if the air movement is high. For this measure, propeller style fans are hung from the ceiling to provide air motion directly to occupants. Energy savings are assumed to occur, because higher cooling temperature set points are facilitated by the rapid air motion provided by the fans.

Whole House Fans: Whole house fans keep a home cool during the cooling months instead of running the air conditioner. These fans typically consume 0.22kW (1/3 hp) about one-third the consumption of a central air conditioner. These fans pull cool air from the outside, move air through the house, and/or remove hot air through the attic.

Attic Venting: Attic venting reduces heat gain in the summer and prevents condensation (humidity) in the winter. This measure involves a motor-driven, thermostat-controlled fan.

HVAC Diagnostic Testing And Repair: This measure involves diagnostic and repair services for existing central air conditioners to improve their efficiency. Inspection and services of AC systems involves checking the refrigerant level, cleaning the coils, cleaning the blower, and cleaning or replacing filters.

Additionally, furnace adjustments increase efficiency by insuring that the furnace fan stays on as long as there is heat in the exchanger. Fan off control is adjusted to maximize efficiency. Additional adjustment of the thermostat anticipator, which controls gas burn time, can increase furnace cycling efficiency.

Duct Repair: An ideal duct system would be free of leaks, especially when the ducts are outside the conditioned space. Leakage in unsealed ducts varies considerably with the fabricating machinery used, the methods for assembly, installation workmanship, and age of the ductwork. To seal ducts, a wide variety of sealing methods and products exist. Care should be taken to tape or otherwise seal all joints to minimize leakage in all duct systems and the sealing material should have a projected life of 20 to 30 years. Current duct sealing methods include use of computer-controlled aerosol and pre- and post-sealing duct pressurization testing.

Duct Insulation: Insulation material inhibits the transfer of heat through the air-supply duct. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated flexible duct, duct board, duct wrap, tacked or glued rigid insulation, and water proof hard shell materials for exterior ducts. Duct insulation for existing construction involves wrapping un-insulated ducts with an R-4 insulating material.

Building Envelope

Ceiling and Floor Insulation: Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. By inhibiting the flow of heat energy, thermal insulation can conserve energy by reducing heat loss or gain of a structure. An important characteristic of insulating materials is the thermal resistivity or R-value. The R-value of a material is the reciprocal of the time rate of heat flow through a unit of this material in a direction perpendicular to two areas of different temperatures.

Insulation material inhibits the transfer of heat through the roof, wall or floor structure. The type of building construction helps define insulating possibilities. Because there are a variety of structure construction types, the choice of insulation materials will also vary. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; batts of fiberglass; and rigid polystyrene.

Two ceiling insulation measures are included in this study: (1) adding R-19 insulation to an un-insulated home, and (2) increasing insulation from R-19 to R-38 for homes with some existing insulation.

Floor Insulation: Floor insulation involves adding R-19 insulation to raised floors in existing homes. Most newer homes are constructed with cement slab foundations, in which case this measure does not apply.

Wall Insulation: For existing construction, this measure involves adding R-11 insulation to un-insulated walls. This is usually accomplished by drilling holes into the building's siding and blowing in insulation material.

Infiltration Reduction: Infiltration reduction measures include weatherstripping and caulking. These measures reduce energy consumption by improving the tightness of the building shell and limiting heat gain and loss. Home installation of these measures is usually most effective at fixing easily found leaks. Professional installation of these measures sometimes includes use of blower doors and is usually much more effective than home installation methods. Measure costs for this study reflect professional weatherization.

Cool Roofs: The color and material of a building structure surface will determine the amount of solar radiation absorbed by that surface. By utilizing the appropriate, lighter-colored building materials (and lower solar absorption), the roof will absorb less solar radiation and consequently reduce the cooling load.

Double Pane Clear Windows to Double Pane, Med Low-E Coating: Windows affect building energy use through thermal heat transfer (U-value), solar heat gains (shading coefficient), daylighting (visible light transmittance), and air leakage. The performance of a window is determined by the type of glass, the number of panes, the solar transmittance, the thickness of, and the gas type used in the gap between panes (for multi-pane windows).

The best spectral selectivity would have a high transmittance over the entire solar spectrum. This would include admitting the most solar radiant heat and a low emissivity (high reflectivity) over the long-wavelength infrared radiation spectrum, to reflect low-temperature radiant heat from the walls and room furnishings back into the building. Conventional low-emittance (low-E) windows approximate this ideal performance.

Window Film: This measure involves application of a dark-colored film to the existing windows of a home. The film lowers the shading coefficient of a window, reducing the amount of solar heat gain of a building, and thus decreasing the cooling load for the building.

Sunscreen: This measure is a dark colored screen that is attached to the outside of a window. Similar to window film, this measure lowers the shading coefficient of a window.

Lighting

Compact Fluorescent Lighting (CFLs): Compact fluorescent lamps are designed to replace standard incandescent lamps. They are approximately four times more efficient than incandescent light sources. Screw-in modular lamps have reusable ballasts that typically last the life of four lamps.

Appliances

Energy Star Efficiency Refrigerator: ENERGY STAR® refrigerators must exceed the stringent new July 1, 2001 minimum federal standards for refrigerator energy consumption by at least 10 percent. An energy efficient refrigerator/freezer is designed by improving the various components of the cabinet and refrigeration system. These component improvements include cabinet insulation, compressor efficiency, evaporator fan efficiency, defrost controls, mullion heaters, oversized condenser coils, and improved door seals.

Refrigerator Early Replacement: For this measure we assume replacement of an older refrigerator (10 years old or more) with a new standard-efficiency refrigerator. The early replacement assumes that the same new refrigerator would have been bought, only six years later. Savings for this measure result for six years because the newer refrigerators, given the stringent efficiency standards implemented in 2001, use much less energy than older units.

High Efficiency Freezer: Stand-alone freezers include either upright or chest models. Efficient freezers should exceed standard efficiencies by 10 percent or more.

Energy Star and High Efficiency Clothes Washer: A standard clothes washer uses various temperatures, water levels, and cycle durations to wash clothes depending on the clothing type and size of the laundry load.

A high-efficiency vertical-axis clothes washer, which eliminates the warm rinse option and utilizes a spray technology to rinse clothes, can significantly reduce washer-related energy. Such machines also utilize a spin cycle that eliminates more water from the clothes than conventional clothes washers and are generally driven by more efficient motors.

A horizontal axis clothes washer utilizes a cylinder that rotates horizontally to wash, rinse, and spin the clothes. These types of washing machines can be top loading or front loading, and utilize significantly less water (hot and cold) than the standard vertical axis machines. A vertical axis machine generally fills the tub until all of the clothes are immersed in water. In contrast, the horizontal axis machine only requires about one third of the tub to be full, since the rotation of the drum around its axis forces the clothes into the water and thus can drastically reduce the total energy use for washing. These machines are also easier on clothes and use less detergent.

Energy Star Dishwasher: ENERGY STAR labeled dishwashers save by using both improved technology for the primary wash cycle, and by using less hot water to clean. They include more effective washing action, energy efficient motors and other advanced technology such as sensors that determine the length of the wash cycle and the temperature of the water necessary to clean the dishes.

The ENERGY STAR qualified models with internal water heaters boost the water temperature inside the dishwasher to at least 140^{o}F. This allows one to turn down the thermostat on the household water heater to 120 degrees, reducing water heating costs by up to 10 percent.

High Efficiency Clothes Dryer (gas and electric): A standard clothes dryer uses various temperatures and drying durations to dry clothes depending on the clothing type and size of the laundry load. In general, the dryer cylinder is spun to rotate the wet clothes, as hot air is injected into the drying cylinder. Wet moist air is then exhausted from the dryer. The cycle duration is manually set.

An energy efficient clothes dryer uses a moisture-sensing device to terminate the drying cycle rather than using a timer. In addition, an energy efficient motor is used for spinning the dryer tub.

Water Heater

High Efficiency Water Heater (electric or gas): The electric water heater measure involves substitution of a standard efficiency water heater (with an energy factor, EF, of 0.88) with a high efficiency water heater (EF of 0.93). For gas, a 0.60 EF water is replaced with a high efficiency, 0.63 EF, water heater. Energy factors are a measure of water heater efficiency that combines recovery efficiency with standby losses. While California Title 20 appliance standards require minimum EFs of 0.544 for 40 gallon gas water heaters, we have utilized a EF of 0.60 as our base because the majority of new water heaters being installed have EFs of 0.60 or more, and effective January 2004, the required minimum EF will be 0.594 (for 40 gallon units).

Heat Pump Water Heater: Air-to-water heat pump water heaters extract low-grade heat from the air then transfer this heat to the water by means of an immersion coil. This is the most commonly utilized residential heat pump water heater. The air-to-water heat pump unit includes a compressor, air-to-refrigerant evaporator coil, evaporator fan, water circulating pump, refrigerant-to-water condenser coil, expansion valve, and controls. Residential heat pump water heaters replace base electric units with the same tank capacities.

Solar Water Heater: Heat transfer technology that uses the sun's energy to warm water. Solar water heaters preheat water supplied to a conventional domestic hot water heating system. The energy savings for the system depend on solar radiation, air temperatures, water temperatures at the site, and the hot water use pattern.

High Efficiency Boiler: Boilers provide hot water for some multifamily dwellings. This measure involves installation of a high efficiency gas boiler (95 percent efficiency) instead of a standard 82 percent efficient boiler.

Boiler Controls: Controllers optimize the performance of a boiler by learning the daily demand pattern of domestic hot water and adjusting the water supply accordingly. The controllers usually have the ability to automatically lower water temperatures during low use periods.

Low Flow Showerhead: Many households are still equipped with showerheads using 3+ gallons per minute. Low flow showerheads can significantly reduce water heating energy for a nominal cost. Typical low flow shower heads use 1.0-2.5 gallons per minute compared to conventional flow rate of 3.5-6.0 gallons per minute. The reduction in shower water use can substantially lower water heating energy use since showering accounts for about one-fourth of total domestic hot water energy use.

Pipe Wrap: Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. By inhibiting the flow of heat energy, thermal insulation can conserve energy by reducing heat loss or gain. Insulation material inhibits the transfer of heat through the hot water tanks and hot water pipe. In residential applications, usually the first five feet of pipe closest to the domestic water heater are insulated. Small pipes are insulated with cylindrical half-sections of insulation with factory applied jackets that form a hinge-and-lap or with flexible closed cell material.

Faucet Aerators: Water faucet aerators are threaded screens that attach to existing faucets. They reduce the volume of water coming out of faucets while introducing air into the water stream. A standard non-conserving faucet aerator has a typical flow rate of 3-5 gallons per minute. A water-saving aerator can reduce the flow to 1-2 gallons per minute. The reduction in the flow rate will lower hot water use and save energy (kitchen and bathroom sinks utilize approximately 7 percent of total domestic hot water energy use). Under current Title 24 Standards, new faucets can have a maximum flow rate of 2.2 gallons per minute; thus, this measure applies only to retrofits.

Water Heater Blanket: Adding water heater blankets to the hot water storage tank can prevent standby heat loss. This measure is especially effective when installed on older, less-insulated tanks. Insulation levels on automatic storage heaters can be increased by installing a fiberglass blanket on the outside of the tank. This increase in insulation reduces standby losses and saves energy.

Pools

High Efficiency Pool Pump and Motor: This measure involves the replacement of a standard-efficiency motor and low volume pump with a smaller high-efficiency motor and a new high-volume pump.